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OTS: 60-11,853

JPRS: 2964

5 July 1960

A VALUABLE WORK ON COMPARATIVE PHYSIOLOGY

- USSR -

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TRANSFER TO MAIN FILE

19990624 067

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WASHINGTON 25, D. C.

~~Price: \$0.50~~

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
205 EAST 42nd STREET, SUITE 300
NEW YORK 17, N. Y.

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

DTIC QUALITY INSPECTED 4

JPRS: 2964

CSO: 4053-N

A VALUABLE WORK ON COMPARATIVE PHYSIOLOGY*

Following is a translation of a book review written by Corresponding Member of the Acad. of Sci. USSR Ye. M. Kreps in Vestnik Akademii Nauk SSSR (Herald of the Academy of Sciences USSR), Vol. 29, No. 12, December 1959, pages 106-108.⁷

The book being reviewed was published on the eve of two jubilees for evolutionary science: 1958 marked the completion of 100 years from the time of the publication of the first communication of C. Darwin and A. Wallace concerning the theory, created by them, of the development of the organic world, and in this year the scientific world noted the 100th anniversary of the appearance of the famous work of C. Darwin, "The Origin of Species." The scientific meetings and conferences devoted to these anniversaries, and first of all the Fifteenth International Zoological Congress, which have proceeded under the sign of the jubilee of the Darwinian theory, have shown how great the role of comparative physiology is at the present time in the general science of the evolution of the organic world.

The work of Kh. S. Koshtoyants emerges from the boundary of comparative physiology in its significance. Having set as its task to consider in order the evolution of the functions of the nervous system from its rudiments in the primitive forms up to the higher manifestations of the activity of the brain in the most highly organized animals, the author also systematizes the data on development of nervous activity in ontogenesis, in the individual

*Kh. S. Koshtoyants. Fundamentals of Comparative Physiology. Vol. II. Comparative Physiology of the Nervous System. Publications of the Academy of Sciences USSR, Moscow, 1956, 636 p / 4 inclusions, press run, 5,000 copies, price 35 rubles 70 kopecks.

development of both invertebrate and vertebrate animals. The book consists of a very rich summary of the materials pertaining to the development of the functions of the nervous system, the functions of stimulability in the animal world; it appears to be the only monograph of this kind in existence in world literature.

The author has performed an enormous amount of work pertaining to the study, selection, and systematization of both/Soviet and foreign literature. An expert in the history of physiology, and especially the history of Russian science, he has been able to rescue from oblivion many very interesting, but now almost unknown investigations of Russian scientists of the beginning and middle of the nineteenth century, and often to establish their priority in the discovery of important scientific facts. The detailed bibliography, brought down to 1957, renders this book exceptionally valuable for all those working in the given field.

The author has long merited wide fame by numerous investigations in the field of comparative physiology. In reading the book important additions are occasionally encountered, introduced into the problem being analyzed by the works of Kh. S. Koshtoyants and his co-workers.

The experience of an investigator and a critical approach have permitted Kh. S. Koshtoyants to select from the enormous literature pertaining to the physiology of the nervous system in the animal world all that is really important, to dwell more profoundly on the controversial questions, to express his own, always well-founded point of view on them, and at the same time to indicate the necessity of further investigations, if the trustworthiness of the communicated facts and observations, however interesting they may have been, evokes doubt. The problem is illuminated in the book from the position of dialectical materialism; the dicta of the classics of materialist philosophy of F. Engels and V. I. Lenin are presented, the important role in the development of evolutionary physiology of such workers of progressive science as C. Darwin, I. M. Sechenov, I. P. Pavlov, N. Ye. Vvedenskiy, L. A. Orbeli is underlined.

In considering the evolution of the functions of the nervous system in the endless diversity of organization of the animal world from the amoeba to man, the author does not isolate function from form. On the contrary, all that is set forth is based on the data of morphology. Each section, devoted to the physiology of the nervous system of some group of animals (type, class), is headed by a brief sketch of the structure of the nervous system of this

group, based on current works and summaries, predominantly of Soviet investigators.

The Pavlovian "principle of structurality" permeates the book and it is simultaneously characterized by another principle, characteristic of our stage of development of biology -- the attempt to understand the functional activity of the nervous system from the point of view of metabolism, biochemical conversions proceeding in the nerve tissue, and of the enzyme systems controlling these reactions. Wherever possible, differences in the physiological manifestations are explained by the author by differences in the biochemical conditions or processes. He himself is responsible for numerous investigations in this direction, in particular, the establishment of a fact which is universal for the entire animal world, dealing with the significance of free sulfhydryl groups of proteins for the normal accomplishment of the processes of excitation and of its conduction in all stimuable tissues. Modern concepts concerning the biochemical nature of nerve excitation, controllable by enzymes, are familiar to the author, who is an active propagandist of what he calls the "enzymatic-chemical nature of nerve excitation."

The biochemical facts, interesting from the point of view of the phylogenesis of the animal world, which permit new light to be cast on the genetic bonds of phylogenetic groups, are not omitted anywhere in the book. Interesting general biological patterns are underlined, the generality of the action of certain biologically active substances, for example, the acetylcholine-cholinesterase systems in all types of movement -- ameboid, ciliary, muscular -- or of acetylcholine and adrenalin in the neural structures of organisms, belonging to groups of the animal world which are mutually remote, are found at the opposite poles of the phylogenetic series, both vertebrates and insects.

On the other hand, the differences in the chemistry of neurohumoral mechanisms in various groups of animals are also underlined everywhere, where such differences are clearly manifested.

All the enormous mass of factual data collected in the book is subordinated to a basic idea -- to show the material continuity of the processes of stimulation, as well as the adaptive character of the processes of genesis and development of the functions of the nervous system and of various kinds of manifestation of this activity. The author also devotes attention to the ecological factor as a factor of the evolution of the function of closing the circuit itself, and to the role of rates, which in the book is somewhat shifted to the background.

Finally, and this is very important, the book, which is essentially a handbook, a manual of comparative physiology, reads easily and is written in an interesting manner.

It is desirable now to dwell briefly on the individual chapters.

In the first chapter, in which the principles of the general physiology of living structures are set forth, the phenomena of excitation and the processes lying at the basis of neural function are described. The author dwells on the genesis and development of inhibition in the nervous system and analyzes its role in the development of the switching function. Evolution is briefly traced, although this is incidental, except possibly in the presumption of excitation in the nervous system in the formation of the temporary bond. The biological role of temporary bonds is illuminated from the Pavlovian positions as a factor of the adaptation of the animal to the medium.

The second chapter is exceptionally interesting. In it is given a systematic description of the phylogenetic and ontogenetic changes of the basic characteristics of nerve tissue -- excitability, lability, chronaxy, local excitation, its conversion into spreading excitation, the speed of conduction of the excitation, etc. An enormous quantity of information is presented, obtained by Soviet and foreign investigators, and their views on many debatable questions are set forth critically.

In the third chapter the most primitive forms of the phenomena of stimulability and movement are considered -- protoplasmic (in plants, protozoa), ameboidal, ciliary, the transitions and succession of individual forms of movement, the similarity and difference of the metabolic bases of these forms of movement.

Chapters four through eleven are devoted to the exposition of data concerning structure, as well as results of the comparative-physiological study of nervous systems in all types of invertebrates.

The core of this most general and fact-saturated section of the book appears to be the process of gradually increasing complexity, of differentiation and centralization of the nervous system, of the accumulation of neural elements in nodes, ganglia, and the disappearance of ganglion cells in the commissures, of gradual development of the peripharyngeal ring -- the supra- and the subpharyngeal ganglia, the "brain" of invertebrates. The author justifiably associates this process of cephalization or concentration of neural elements at the anterior end of the body with the presence in the given end of the most important receptors, the eye and the statocysts; here he expresses his

solidarity with the conceptions of the creator of the science of evolutionary histology, A. A. Zavarzin, and of the species morphologist, V. N. Beklemishev. Everywhere, the leading significance of the receiving portion of the nervous system in the evolutionary development of one or another sections of the brain and the central nervous system as a whole is underlined -- a view, which had been advanced in his own time by I. P. Pavlov.

In these chapters, many general questions of the physiology of the central nervous system are touched upon which are considered in the cases of the ever increasing complex organization and activity of the brain. The author also deals with questions of the evolution of neurohumoral relations in the invertebrate world, the question of "spontaneous" rhythmic activity of the nervous system, he correctly criticizes the notions of certain investigators concerning some sort of autonomic spontaneous activity of the nervous system, independent of external influences, and returns this question to the solid positions of reflex theory.

In places where the logic of things permits, the author lingers on problems which have practical significance. Thus, in analyzing the physiological features and pharmacological sensitivity of various parts of the nervous system and the neuromuscular apparatus of insects, he illuminates the mechanism of action of various insecticides from this point of view.

The last chapters of the book are devoted to the comparative physiology and formation of the functions of various sections of the central nervous system of vertebrates -- the spinal cord, medulla oblongata, mesencephalon, and diencephalon, the cerebellum and the cerebral hemispheres.

Critically generalizing the often contradictory data of many investigators, the author discloses the picture of all the functions of the spinal cord of vertebrates which become complicated in the process of development, from the cyclostomata to the mammals, thereby presenting convincing data on the gradual modifications and replacement of functions in the reflex activity of the spinal cord. At the basis of the description of the reflex activity of the spinal cord and other sections of the brain are the view of I. M. Sechenov and L. A. Orbeli on the evolution of the coordination mechanisms in the nervous system.

The author widely enlists the data of ontogenetic investigators, where a great deal has been accomplished by Soviet scientists, in an analysis of the evolution of the

functions of the central nervous system. Less attention is paid in the book to that methodological method which had been introduced into evolutionary physiology by L. A. Orbeli, specifically, the analysis of the disturbances arising in the presence of various experimental influences on the organism -- such as section of the nerves, disconnection of the peripheral and the central nervous systems, exclusion of the higher sections of the brain, etc. It is true that a broader consideration of this question would have emerged from the frame of comparative physiology proper.

The discussion of questions of the evolution of the cerebral hemispheres occupies a considerable place in the book. The author gives a detailed review of the literature, Russian and foreign, pertaining to the development of the structure and functions of the higher sections of the brain and shows the role of the teaching of I. P. Pavlov concerning conditioned reflexes in the creation of the evolutionary physiology of the nervous system.

The book of Kh. S. Koshtoyants, the appearance of which must be acknowledged to be an outstanding event in physiology, is already well known abroad. At the time of the International Zoological Congress in London in 1958, I witnessed the lively interest and impatience with which British scientists, engaged in the study of comparative physiology, were waiting for the appearance of a translation of this book.

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